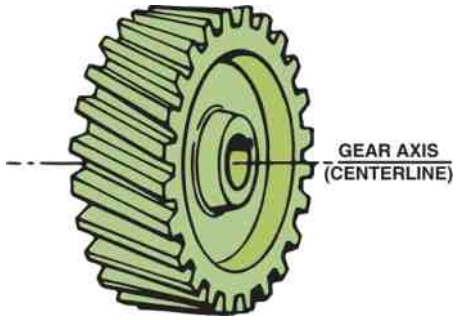
122

MANUAL TRANSMISSIONS/ TRANSAXLES

Figure 122-1 Spur gears have straight-cut teeth.

Figure 122-2 The teeth of a helical gear are cut at an angle to the gear axis.



FREQUENTLY ASKED QUESTION

What Is the Difference Between a Transmission and a Transaxle?

A transmission is used on rear-wheel-drive vehicles, whereas a transaxle is usually used on front-wheel-drive vehicles. A vehicle equipped with a transmission uses a separate differential to split the torque equally to the drive wheels. A transaxle includes a differential assembly. In a transaxle, the differential, sometimes called the *final drive unit*, is incorporated in the construction of the transmission.

Figure 122-3 A spur gear has straight-cut teeth. This design is very strong and is used where strength is important. Spur gears are noisy during operation. Helical-cut gears, on the other hand, operate quietly but create a force in line with the axis of the gears due to the angle of the gear teeth.

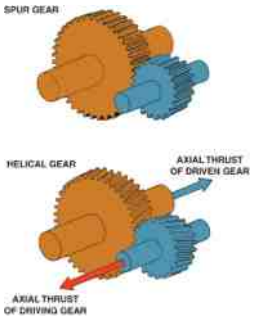


Figure 122-4 A pinion gear meshed with an internal ring gear rotates in the same direction around a parallel axis of rotation.

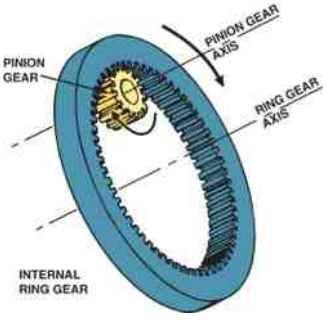


Figure 122-5 When two external gears mesh, they rotate in opposite directions.

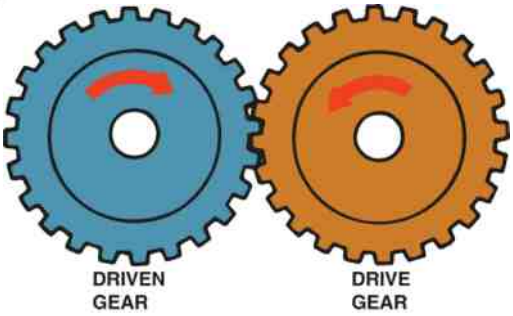


Figure 122-6 Bevel gears are often used to change the direction of rotation and are typically used in differentials.

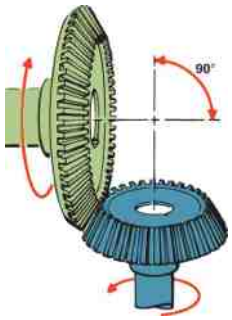


Figure 122-7 A differential uses a hypoid gear set to provide a change in the direction of torque and for gear reduction (torque increases) to the drive wheels.

Figure 122-8 Gear ratio is determined by dividing the number of teeth of the driven (output) gear (24 teeth) by the number of teeth on the driving (input) gear (12 teeth). The ratio illustrated is 2:1.

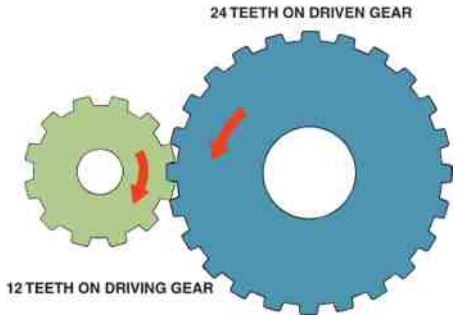


Figure 122-9 This gear combination provides a gear reduction of 3:1.

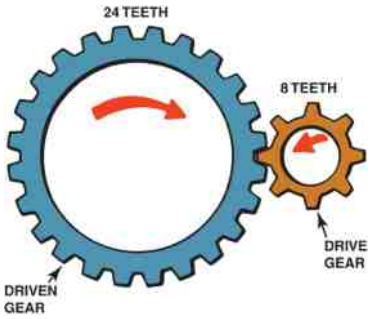


Figure 122-10 This gear combination provides an overdrive ratio of 0.33:1.

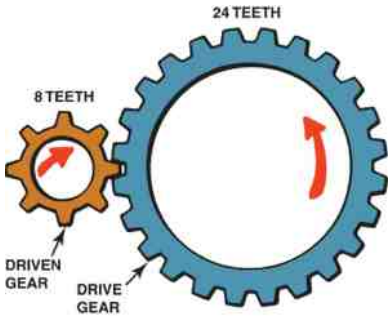


Figure 122-11 Idler gears affect the direction of rotation in a gear train, but not the final drive ratio.

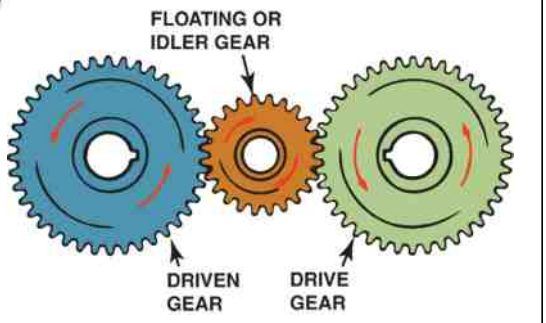


Figure 122-12 Gears apply torque in the same way a wrench applies torque—the force applied multiplied by the distance from the center of the gear equals the torque.

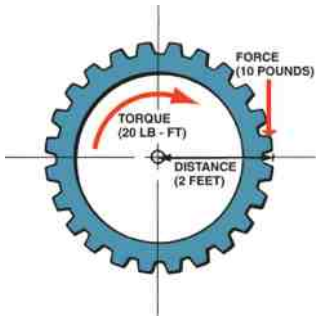


Figure 122-13 A lever can be used to multiply torque, but it does so at the expense of distance or speed.

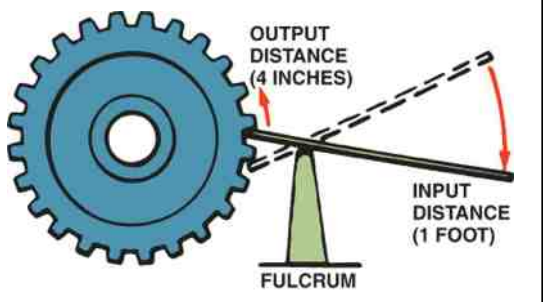


Figure 122-14 Cross section of a five-speed manual transmission showing the main parts.

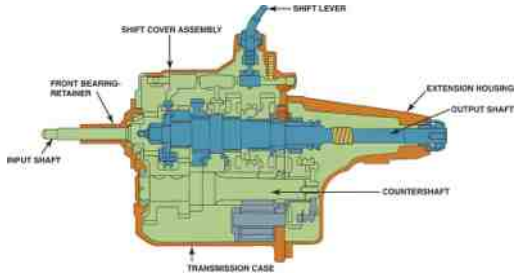


Figure 122-15 Cutaway of a six-speed manual transmission showing all of its internal parts.

FREQUENTLY ASKED QUESTION

What Is Meant by a 77 mm Transmission?

The size (77 mm or about 3 inches) is the distance between the center of the input shaft and the center of the countershaft. The greater this distance, the larger the transmission and the more torque it is capable of handling due to the larger gears.

Figure 122-16 Notice that the countershaft and the main shaft both use gears of increasing size that mesh together.

Figure 122-17 A typical shift mechanism showing the shift detents designed to not only give the driver a solid feel when shifting but also to prevent two gears from being selected at the same time. The shifter also prevents shifting into reverse except from the neutral position.

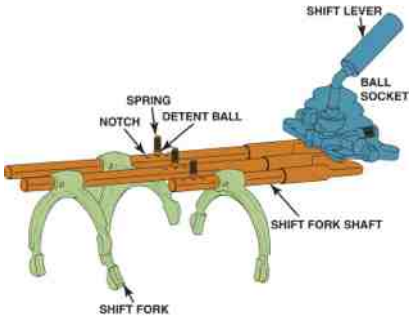


Figure 122-18 The shifter fork fits into the groove of the synchronizer sleeve. When a shift is made, the sleeve is moved toward the speed gear. The sleeve presses the stop ring (synchronizer ring) against the cone area of the speed gear. The friction between the stop ring and the speed gear causes the speed of the two to become equal, permitting the sleeve to engage the gear clutch teeth of the speed gear. When this engagement occurs, the shift is complete.

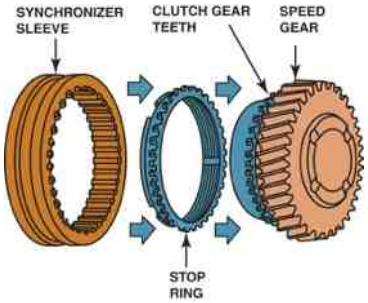


Figure 122-19 Typical synchronizer assembly.

Figure 122-20 Synchronizer keys are attached to the clutch hub and push against the synchronizer ring when the sleeve is being moved during a shift. Notice the grooves on the synchronizer ring. These grooves prevent lubricating oil from becoming trapped between the ring and the cone surface of the speed gear. The grooves also help the ring release from the cone surface when a shift is made out of a gear.

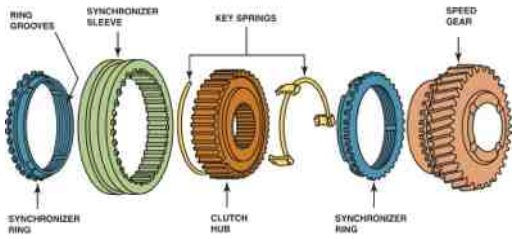
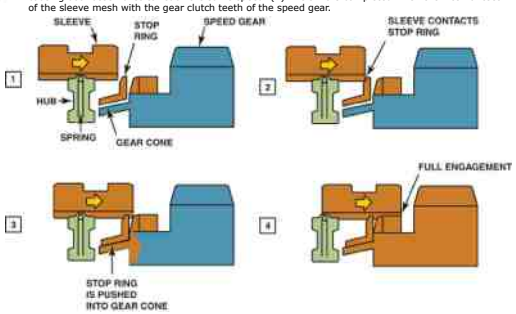


Figure 122-21 A shift sequence starts when the shift fork is moved by the driver, (1) applying a force on the sleeve that moves it toward the speed gear. (2) The sleeve and the inserts contact the stop ring (blocking ring). (3) The synchronizer ring (stop ring) engages the cone on the speed gear, causing both assemblies to reach the same speed. (4) The shift is completed when the internal teeth of the sleeve mesh with the gear clutch teeth of the speed gear.



FREQUENTLY ASKED QUESTION

What Do the Keys Do?

The keys are there to limit the amount of rotation of the ring from 1/2 tooth misaligned in the forward direction, to 1/2 tooth misaligned in the "coast" direction so that both upshifts and downshifts can be made. The detent key springs are designed to "push up" on the keys which have a "bump" on them that aligns with a notch in the inside center of the sliding sleeve. This upward pressure tends to keep the sliding sleeve in the neutral position and prevents unwanted movement toward another unwanted gear.

Figure 122-22 Before reassembling the transmission/transaxle, carefully inspect the splines on the synchronizer sleeves for wear. The shape of the splines helps prevent the transmission/transaxle from jumping out of gear during acceleration and deceleration.

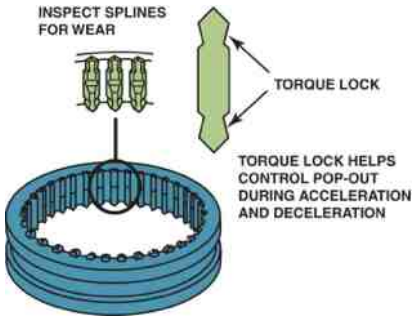


Figure 122-23 A three-piece synchronizer assembly. This type of synchronizer uses two cones, which helps achieve a smooth shift with less driver effort. Many newer transmissions/transaxles use a paper lining similar to that of the clutches in an automatic transmission. The transmissions/transaxles that have these paper linings must use automatic transmission fluid (ATF) for proper operation and long life.

Figure 122-24 In neutral, the input shaft and the countershaft are rotating if the clutch is engaged (clutch pedal up), but no torque is being transmitted through the transmission.

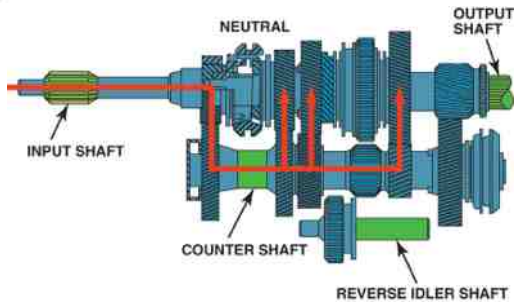


Figure 122-25 In first gear, the 1–2 synchronizer sleeve is moved rearward, locking the first speed gear to the output shaft. Torque is transmitted from the input shaft to the countershaft and then to the output shaft.

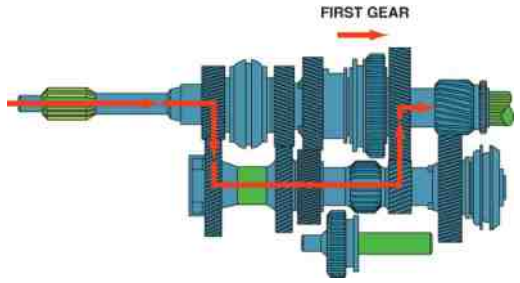


Figure 122-26 In second gear, the 1–2 synchronizer sleeve is moved forward, which locks the second speed gear to the output shaft.

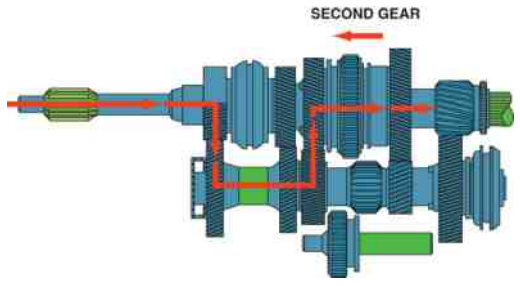


Figure 122-27 To achieve third gear, the shaft linkage first centers the 1–2 synchronizer sleeve and then moves the 3–4 synchronizer sleeve rearward, locking third speed gear to the output shaft.

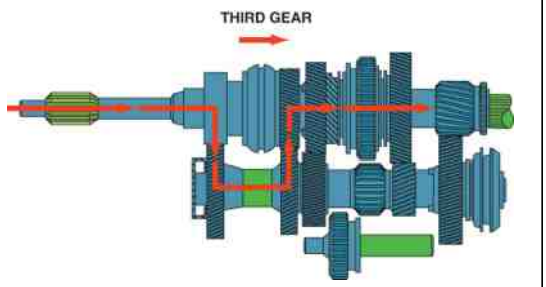


Figure 122-28 In fourth gear, the 3–4 synchronizer sleeve is moved forward, which locks the fourth speed gear to the output shaft.

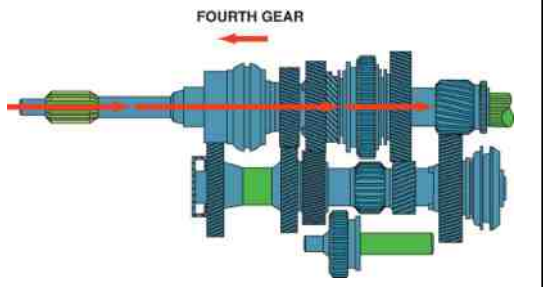


Figure 122-29 To achieve fifth gear, the shift linkage first centers the 3–4 synchronizer sleeve and then moves the fifth synchronizer sleeve toward the fifth speed gear, locking it to the output shaft.

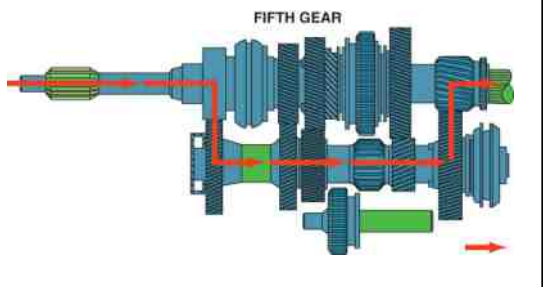


Figure 122-30 Torque flows through the transmission in reverse gear. Note that the idler gear drives the 1–2 synchronizer sleeve gear, which is splined to the output shaft.

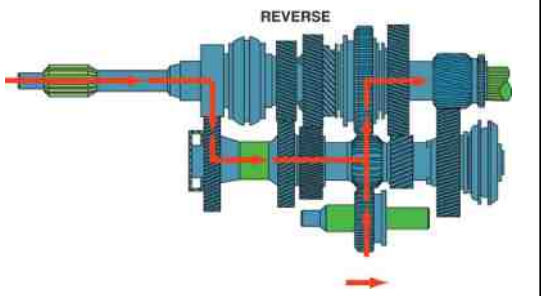


Figure 122-31 Cutaway of a T56 six-speed transmission showing all of its internal parts.

Figure 122-32 Notice that this five-speed transaxle from a Dodge/Plymouth Neon uses synchronizers on both the input and output shafts.

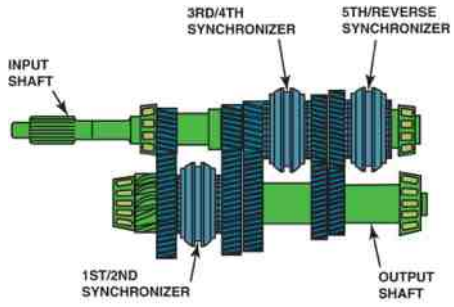


Figure 122-33 Cutaway of a typical manual transaxle showing all of its internal parts including the final drive assembly.

Figure 122-34 When the transmission/transaxle is removed from the vehicle, the engine must be supported. In this case, the engine oil pan is supported with a block of wood to spread the load across the entire oil pan to prevent damage. The block of wood is placed on top of a tall safety stand that allows room for the service technician to work while standing.

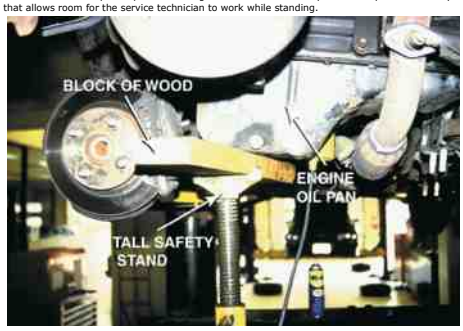


Figure 122-35 A transmission from a restored muscle car from the 1970s. Notice the use of external control rod shift linkage.

Figure 122-36 Typical cable-operated shift linkage used on a front-wheel-drive transaxle.

Figure 122-37 (a) Saturn drive train is removed as an assembly along with the cradle.

(a)

Figure 122-37 (b) The transaxle can now be easily removed from the cradle and the engine.

(b)

Figure 122-38 The shift forks should be inspected for wear.

Figure 122-39 The cost to replace these gears may exceed the cost of a replacement transmission.

TECH TIP

Manual Transmission Service Tips

A wise technician once told a beginning technician to remember these items when working with transmissions:

- Always use a *brass* or *plastic* hammer when pounding on a steel or aluminum component.
- If using a steel hammer, always use a *brass* or *aluminum* punch or place wood between the steel components and the hammer.
- Many parts can be installed in either direction but usually only one way is correct.
- If you are exerting a lot of force, you are probably doing something wrong.
- Many drive train parts are pulled or pressed off and pressed or driven on.

Figure 122-40 It often requires two people to assemble a transaxle because the shaft with the shifter forks needs to be placed into the case as an assembly, as on this unit.

Figure 122-41 (a) During the disassembly of any manual transmission/transaxle, carefully check for the location of the snap rings. Often they are hidden. Consult the factory service manual or unit repair manual for information and procedures for the unit being serviced.

(a)

Figure 122-41 (b) Using snap-ring pliers to remove a snap ring. Many snap rings have an "up" side. Be sure to reinstall any snap rings in the correct direction.

(b)

Figure 122-41 (c) After the snap ring is removed, some components can be simply lifted off the main shaft, while other gears may require the use of a press.

(c)

Figure 122-42 (a) Many gears require that a hydraulic press be used to separate the gear(s) from the shaft. After double-checking that all snap ring retainers have been removed and after checking in the service manual to see which gear needs to be pressed off, carefully position the "bearing splitter" as far inward as possible to avoid damaging the teeth during the pressing operation.

(a)

Figure 122-42 (b) For safety, place an old brake drum over the gear(s) being pressed off. If the gear were to shatter, the parts will be trapped inside the brake drum.

(b)

Figure 122-42 (c) Some transmission disassembly and reassembly procedures require the use of special pullers, such as this tool being used on a NV 4500 transmission.

(c)

REAL WORLD FIX

The Worn Shift Fork Mystery

A vehicle equipped with a manual transmission had to be repaired several times for worn shift forks. Even though the vehicle warranty paid for the repair, both the customer and the service department personnel were concerned about the repeated failures. All technical service bulletins (TSBs) were checked to see if there was an updated, improved shift fork. No luck. Even the manufacturer's technical assistance personnel were unable to determine why the shift forks were wearing out. After the third repair, the service technician rode with the customer to see if the cause could be determined. As the woman driver got into the driver's seat, she placed the handle of her purse over the shifter on the floor and allowed the purse to hang from the shifter. The technician asked the owner if she always placed her purse on the shifter and when she said yes, the technician knew immediately the cause of the worn shift forks. The purse exerted a force on the shifter all the time. This force pushed the shift forks against the synchronizer sleeve. Because the sleeve rotates all the time the vehicle is in motion, the shift forks were quickly worn. The service technician should have determined the root cause of the problem after the first repair. The customer agreed to find another location for her purse so that the transmission problem would not reoccur.

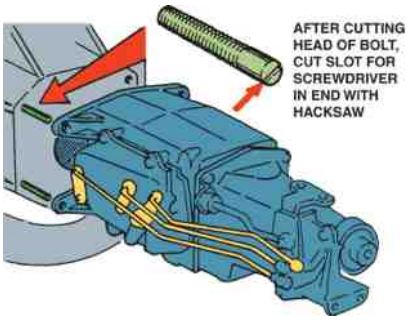
Figure 122-43 Some manual transmissions/transaxles require synchromesh transmission fluid.

TECH TIP

The Headless Bolt Trick

Sometimes parts do not seem to line up correctly. Try this tip the next time. Cut the head off extra-long bolts that are of the same diameter and thread as those being used to retain the part, such as a transmission. ● **SEE FIGURE 122–44.** Use a hacksaw to cut a slot in the end of these guide bolts for a screwdriver slot. Install the guide bolts; then install the transmission. Use a straight-blade screwdriver to remove the guide bolts after securing the transmission with the retaining bolts.

Figure 122-44 Headless, long bolts can be used to help install a transmission to the engine.



NV-1500 MANUAL TRANSMISSION SERVICE 1 A NV-1500 five-speed manual transmission is used in two-wheel drive applications only.

NV-1500 MANUAL TRANSMISSION SERVICE 2 The shifter assembly has been removed. Note the roll pin in the center of the shift lever socket.

NV-1500 MANUAL TRANSMISSION SERVICE 3 Snap-ring pliers are being used to remove the snap ring retaining the input shaft bearing.

NV-1500 MANUAL TRANSMISSION SERVICE 4 The upside down case is being separated showing the countershaft (top) and shift forks.

NV-1500 MANUAL TRANSMISSION SERVICE 5 Before further disassembly can be accomplished, the shift lever socket roll pin must be driven out using a punch and a hammer.

NV-1500 MANUAL TRANSMISSION SERVICE 6 The shift shaft and forks can now be removed.

NV-1500 MANUAL TRANSMISSION SERVICE 7 The reverse idle gear is unbolted from the case and removed.

NV-1500 MANUAL TRANSMISSION SERVICE 8 The output shaft assembly fifth gear (far left) and the synchronizer assemblies.

NV-1500 MANUAL TRANSMISSION SERVICE 9 The bearing is being removed using a bearing splitter and a hydraulic press.

NV-1500 MANUAL TRANSMISSION SERVICE 10 A speed gear (bottom) along with the double row needle bearing used between the shaft and the speed gear. The hub (center) is splined and rotates with the output shaft.

NV-1500 MANUAL TRANSMISSION SERVICE 11 A synchronizer assembly being reassembled. It often takes several hands to hold the hub (center) and the sleeve (outer ring).

NV-1500 MANUAL TRANSMISSION SERVICE 12 A hydraulic press is used to reassemble output shaft and bearing.

NV-1500 MANUAL TRANSMISSION SERVICE 13 The assembled output shaft is held against the counter shaft to double check that all of the gears have been correctly assembled.

NV-1500 MANUAL TRANSMISSION SERVICE 14 The assembled output shaft and counter shaft are being reinstalled in the transmission case.

NV-1500 MANUAL TRANSMISSION SERVICE 15 The case halves are bolted together.

NV-1500 MANUAL TRANSMISSION SERVICE 16 The last step is to assembly the shift lever and check for proper operation in all gear positions.

NV-350 TRANSAXLE SERVICE 1 After the transaxle has been removed from the vehicle and the fluid drained, place the transaxle on a work surface.

NV-350 TRANSAXLE SERVICE 2 The bell housing case half containing the large output shaft front bearing (center) and the input shaft front bearing (smaller bearing on the left).

NV-350 TRANSAXLE SERVICE 3 The differential assembly is simply lifted out of half of the case.

NV-350 TRANSAXLE SERVICE 4 The input and output shafts are a press fit into the bearings and are also retained with a snap ring, which must be removed.

NV-350 TRANSAXLE SERVICE 5 Using a special tool, the input and output shafts are pressed out of the housing using a hydraulic press.

NV-350 TRANSAXLE SERVICE 6 The input shaft can be disassembled using a bearing splitter and a press, or two screwdrivers to pry the gears off the shaft.

NV-350 TRANSAXLE SERVICE 7 This transaxle uses both brass and powdered metal synchronizer rings with a fiber (paper) inner cone surface.

NV-350 TRANSAXLE SERVICE 8 Synchronizer ring gaps are being measured using a feeler (thickness) gauge. The factory specifications are usually 0.040 in. to 0.069 in.

NV-350 TRANSAXLE SERVICE 9 The gear clutch teeth should be inspected for wear.

NV-350 TRANSAXLE SERVICE 10 An assembled synchronizer assembly containing a sleeve, keys, springs, and detent.

NV-350 TRANSAXLE SERVICE 11 The input shaft (left) and the output shaft (right) are checked for proper assembly before being installed into the case.

NV-350 TRANSAXLE SERVICE 12 The differential bearing preload is determined by measuring for zero end play; then adding the thickness shim under the bearing cup.

NV-350 TRANSAXLE SERVICE 13 The bearing cup is being installed using an installation tool and a hammer.

NV-350 TRANSAXLE SERVICE 14 All of the shift forks and shift arms must be aligned properly before installing the components into the case.

NV-350 TRANSAXLE SERVICE 15 All of the components, including the differential (right), the output shaft (center), and the input shaft (left), plus the shift linkage are installed and checked for proper positioning.

NV-350 TRANSAXLE SERVICE 16 The case halves being reinstalled. The bearings (top) must be pressed back onto the input and output shafts using a press.

NV-350 TRANSAXLE SERVICE 17 The bell housing case being reattached.

NV-350 TRANSAXLE SERVICE 18 The completed assembly. Notice the bearing cover (top) has already been installed.